VIII.2 Clean Energy Research (New Project)*

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**Congressionally directed project*

Objectives

The objectives of this work include:

- Advancing thermochemical hydrogen production processes
- Studying the effect of metal dopants, proprietary additive, and Al powder on dehydrogenation and rehydrogenation of complex metal hydrides (alanates)
- Investigating the storage and retrieval of hydrogen from sodium borohydride
- Analyzing the effect of CO and H_2S on fuel cell membrane electrode assembly durability
- Developing mathematical models to characterize the performance and aging of fuel cell cathodes

Technical Barriers

This project addresses the following technical barriers from the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan:

- M. Hydrogen Capacity and Reversibility
- N. Lack of Understanding of Hydrogen Physisorption and Chemisorption
- P. Durability
- Q. Regeneration Processes for Irreversible Systems
- V. High- and Ultra-High-Temperature Thermochemical Technology

Approach

The DOE Roadmap states, "Expanded use of hydrogen as an energy carrier for America could help address concerns about energy security, global climate change, and air quality." One advantage of hydrogen is that it can utilize a variety of feedstocks and a variety of production technologies. Feedstock options include fossil resources, such as coal and natural gas; and renewable resources, such as biomass and water. Production technologies include thermochemical, biological, electrolytic, and photolytic processes. Energy needed for these processes can be supplied through fossil, renewable, or nuclear sources. Ultimately, a spectrum of feedstocks and technologies for hydrogen production will be necessary to address energy security and climate change concerns. Also, hydrogen will have to be stored and used to produce electrical energy.

Our research on clean energy will be focused on hydrogen production, storage, and use. Our research plan consists of five projects. Our first project, Low Temperature Electrolytic Hydrogen Production (Dr. John Weidner), will focus on the production of hydrogen by electrolysis of anhydrous gaseous HCl and by the electrolysis of gaseous SO_2. Both of these electrolysis processes are steps in proposed thermochemical processes for the production of hydrogen.

Our second project, Development of Complex Metal Hydride Hydrogen Storage Materials (Dr. James Ritter), will focus on the storage and retrieval of hydrogen in metal doped complex metal hydrides (alanates). New materials will be developed and tested to determine their feasibility as a hydrogen storage media.

Our third project, Hydrogen Storage Using Chemical Hydrides (Dr. Michael Matthews), will focus on storage and retrieval of hydrogen from chemical hydrides. Chemical hydrides such as sodium borohydride ($NaBH_4$) to store and release hydrogen will be investigated. Several important questions such as how to manage the heat released upon reaction of $NaBH_4$ with water will be addressed in this project.

Our fourth project, Diagnostic Tools for Understanding Chemical Stresses and Membrane and Electrode Assembly (MEA) Durability Resulting from Hydrogen Impurities (Dr. John Van Zee), will focus on the durability of the MEA in a Polymer Electrolyte Membrane (PEM) fuel cell subject to poisons such as CO and H_2S.

Our fifth project, Durability Study of the Cathode of a PEM Fuel Cell (Dr. Ralph White), will be focused on developing mathematical models that will be used to characterize the performance and aging of the cathode in a PEM fuel cell. These models will be compared to experimental data and used to predict the effect of aging (performance degradation with time) of the cathode under normal and transient operating conditions.